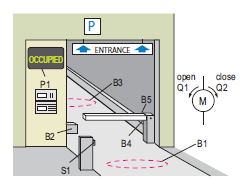
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**PLC Applications**

Module 4: Analog programming blocks





PREPARED BY

**Academic Services Unit**

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Module 4: Analog programming blocks

**Module Objectives**

Upon successful completion of this module, students will be able to:

* Analyze a control task that uses analog inputs.
* Connect a potentiometer to LOGO! controller and use it for simple control tasks.
* Configure control task hardware by calculating the required resistance for a given potentiometer’s specifications.
* Adjust the ON/OFF delay timers’ parameters using a potentiometer.
* Use Analog comparator and analog amplifier programming blocks.

**Module Contents:**

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| **4.1 Introduction**  A signal is any type of physical quantity that conveys information.  The following examples show different types of signals:   * When you talk to any one you use Audio signal. * To turn a light ON you need to send an electrical signal. * This text is another kind of signal.   Electrical signals can be classified into analog signals and digital signals.  An analog signal is a kind of signal that varies continuously, figure 4.1 A. While a digital signal has discrete levels, figure 4.1 B.   |  |  | | --- | --- | | untitled.bmp  A | untitled.bmp  B | | Figure 4.1 Analog signal (A) and Digital signal (B) | |   Consider a light switch that is either ON or OFF, this light switch is an example of a digital input device; on the other hand think about a dimmer switch that allows you to vary the light in different degrees of brightness. In this case the switch has potentiometer that can be used as an analog input. Digital inputs are used to control digital signals while analog inputs are used to control analog signals.  Many signals in our daily life are analog signals, for example, voice, audio, video, temperature, pressure, or position.  In the previous modules, techniques were discussed for designing logical control systems that contain digital inputs, which can only be ON or OFF.  In this module we will examine analog inputs and analog programming blocks, so that we can design continuous control systems.    **4.2 Processing analog quantities**  The LOGO! 12/24RC is equipped with the inputs I7 and I8, which can also be programmed as analog inputs (AI1 and AI2).  LOGO! can read voltages from 0 to 10 V or currents from 0 to 20 mA at its analog inputs. Therefore, the physical quantities (e.g. temperature, pressure, speed etc.) must be converted into electrical quantities. This conversion is performed by an external sensor.  Figure 4.2 shows the steps required to process analog inputs.   |  | | --- | | untitled.bmp | | Figure 4.2 Steps required to process analog inputs |   In figure 4.2 a sensor is connected to the analog input of LOGO!. It converts a physical quantity into an electrical signal. This value of signal lies within the typical range of this sensor. LOGO! reads an electrical quantity at the input and convert it into a standardized value within the range of 0 to 1000. This value is then processed by the special analog functions used in the program. Based on the program conditions, LOGO! then switches ON or OFF an external actuator.  **4.3 Connecting potentiometer to LOGO!**  For LOGO! Controller the input voltage range is 0-10V. When connecting any analog input this range must be taken into consideration. To get a 10V maximum reading with a full rotation of the potentiometer (depending on the potentiometer input voltage), sometimes you have to connect another series resistor.   |  | | --- | | untitled.bmp | | Figure 4.3 Connecting potentiometer to LOGO! |   For example, if there is an input voltage of 24 V and you want to use a potentiometer to give a 10V input voltage as a maximum value, then the difference in voltage can be achieved by connecting a resistor in series with the potentiometer such that a maximum 10V value is obtained with a full rotation of the potentiometer.  The following formula can be used to obtain the value of the required resistor:  Example: A 20KΩ potentiometer is to be used as an analog input for a LOGO! Controller, if the supply voltage is 24V, find the value of the resistor that should be connected in series with this potentiometer.  Solution: 4.4 Analog threshold triggerThe output of this programming block is set or reset depending on two configurable thresholds; one is ON threshold the other is OFF threshold.  |  | | --- | | untitled.bmp | | Figure 4.4 Analog threshold trigger programming block |   Calculation rule   * If threshold (On) >= threshold (Off), then:   Q = 1, if the actual value Ax > On.  Q = 0, if the actual value Ax <= Off.   * If threshold (On) < threshold (Off), then:   Q = 1, if On <= the actual value Ax < Off.   |  | | --- | | untitled.bmp  **A** | | untitled.bmp  **B** | | Figure 4.5 Analog threshold trigger, timing diagram |   The following function block diagram can be used to switch ON an Air Conditioning machine when the temperature is more than 23 and OFF when the temperature is less than 19, this will maintain the room at an optimum temperature and will save energy too.   |  | | --- | | untitled.bmp | | Figure 4.6 Controlling conditioning machine |   **Lab activity 1 page : 11**  **4.5 using potentiometer as parameter for timer and counter**  It is possible and very useful to control a parameter for timer or counter using a potentiometer. Like in timers, ON-delay and OFF-delay times can be left to the operator for adjustment without changing the program; instead the operator will use a potentiometer for this purpose.  The same thing applies to counter; a number of items in counter can also be left to the operator for adjustment.  The analog input values of the potentiometer can be captured from an analog input. The timer value of an on/off delay or the switch on/off limit off a counter can be linked to the analog value. To do this follow these steps:   * Open the Properties dialog of the counter or timer element. * Via the "Reference" button specify the analog value to be used as parameter.  |  | | --- | | untitled.bmp | | Figure 4.7 Using potentiometer as parameter for timer |   **Lab activity 2 page:14**  **4.6 Analog comparator and Analog amplifier**   |  |  | | --- | --- | | Analog comparator is used to compare between two analog signals, The output of this programming block is set and reset depending on the difference between those two signals (Ax – Ay) and on two configurable thresholds (ON-threshold and OFF-threshold). | untitled1.bmp | |  | Figure 4.8 Analog comparator |   Figure 4.9 shows an example of analog comparator timing diagram:   |  | | --- | | untitled.bmp | | Figure 4.9: An example of analog timing diagram |   Calculation rule   * If threshold On >= Threshold Off, then:  Q = 1, if (actual value Ax - actual value Ay) > On Q = 0, if (actual value Ax - actual value Ay) <= Off. * If threshold On < Threshold Off, then: * Q = 1, if On <= (actual value Ax - actual value Ay) < Off. * Q = 0 otherwise.  |  |  | | --- | --- | | Analog amplifier is used to amplify an analog input signal; the output of this programming block is an amplified version of the input signal. | untitled.bmp | |  | Figure 4.10 Analog amplifier |   Figure 4.11 shows an example of input and output signals for the analog amplifier programming block:   |  | | --- | | untitled1.bmp | | Figure 4.11 I/O signals for the analog amplifier |   **Lab activity 3 page :16** |

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| **4.7 Practical tasks**  **Lab activity 1:** Connecting potentiometer to LOGO! |
| **Objective:** To use potentiometer as an analog input with LOGO! Controller.  You are required to connect a 10KΩ potentiometer to LOGO! Controller that uses 24V power supply, to do so a resistor is required   1. Calculate the required resistance. 2. Connect the potentiometer and a light bulb indicator to the LOGO! Controller as shown in figure 4.12:  |  | | --- | | untitled.bmp | | Figure 4.12 Connecting potentiometer to LOGO! |  1. Is it possible to connect the potentiometer to I1 or I2? Why? 2. Use the LOGO! Soft comfort software to create the following FBD:  |  | | --- | | untitled.bmp | | Figure 4.13 FBD for potentiometer task |  1. What is the name of the programming block B001?  1. What is the function of the programming block B001? 2. For B001 programming block, what is the type of the input signal and output signal?      1. Download and run the previous FBD. Then use the left and right arrows on the LOGO! Controller to display the status of the analog inputs AI.      1. Rotate the potentiometer and notice the values appear on the display unit. Write your observations. 2. When does the light go ON? When does it go OFF?  |  | | --- | | untitled.JPG | | Figure 4.14 Connecting potentiometer to LOGO! | |

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| **Lab activity 2:** Connecting potentiometer to LOGO! |
| **Objective:**  adjust the ON/OFF delay timers’ parameter using  Potentiometer.     1. Use the same circuit in task 1, and create an FBD that displays the input voltage on the LOGO! Display unit. The light should go ON if the input voltage is in the range of 3-7 V.   Simulate and test your program.   |  | | --- | |  |  1. In the previous control circuit, connect a normally open pushbutton to I1. Then create a program that enables the user to turn ON the light for adjustable time duration (1-100sec) using the potentiometer.   Show the timing on the display unit.     |  | | --- | | Draw your program in this area : | |

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| **Lab activity 3:** Analog comparator and Analog amplifier |
| **Objective:**  To use Analog comparator programming block    Two heaters are used to heat 2 different chemicals; one is connected to Q1 and the other is connected to Q2, each chemical tank has a thermocouple followed by an electronic amplifier, it gives voltage in the range of 0-10 V, one thermocouple is connected to I7 to monitor the first chemical temperature and the other is connected to I8 to monitor the second chemical temperature, create an FBD that keeps both chemicals at the same temperature.  Simulate your program.   |  | | --- | | Draw your program in this area : | |

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| **Module Exercise**   1. A potentiometer is to be used to measure the position of a rotating robot (as a voltage divider). The power supply connected across the potentiometer is 5.0 V, and the total wiper travel is 300 degrees. The wiper arm is directly connected to the rotational joint so that a given rotation of the joint corresponds to an equal rotation of the wiper arm. 2. Calculate the resistance required for this control system assuming LOGO! 24VDC is to be used, with maximum input voltage of 10 VDC. 3. Create a program that shows the angular position of the robot on the LOGO! Controller’s display unit. 4. An analog level detector is used to measure the level of water in a tank, the graph below shows the characteristics of this detector.   Create a program that turns a pump ON when the water level is less than 40 cm and turns it OFF when the water level is 120 cm. |